CLAIMS

1. (currently amended) A method of testing in pure bending or~~, optionally in~~ alternating bending, the method comprising the following succession of steps:

a) making or selecting a testpiece~~ (1)~~ having two mutually opposite end grip zones~~ (3, 4)~~ and a bending zone~~ (2)~~ interconnecting the two grip zones~~ (3, 4)~~, ~~said~~the testpiece~~ (1)~~ presenting, in a rest state, a first mean plane~~ (5)~~ crossing the bending zone~~ (2)~~ and each of the grip zones~~ (3, 4)~~ and constituting a first plane of symmetry at least for the bending zone~~ (2)~~, and a mean surface~~ (6)~~ for the bending zone~~ (2)~~ and each of the grip zones~~ (3, 4)~~, ~~which~~ wherein the mean surface ~~(6)~~ is perpendicular to the first mean plane~~ (5)~~;

b) ~~while~~ leaving the testpiece~~ (1)~~ in the rest state~~,~~ rigidly securing its two grip zones~~ (3, 4)~~ so as to define for each of them a respective pivot axis~~ (26, 89)~~ perpendicular to the first mean plane~~ (5)~~ and occupying a determined first position~~ firstly~~ relative to the respective grip zones~~ (3, 4)~~ and a second~~ly~~ position relative to the mean surface~~ (6)~~; and

c) imparting controlled opposing turning movements to the two grip zones~~ (3, 4)~~ of the testpiece~~ (1)~~, optionally in alternation, about the respective pivot axes~~ (26, 89)~~ and away from the rest state, while leaving the pivot axes~~ (26, 89)~~ free to move towards each other or apart from each other, so as to impart optionally alternating bending to the bending zone~~ (2)~~ and so as to study the behavior of the bending zone in pure bending; wherein

~~——~~ the method~~ being characterized in that it~~ is~~ implemented~~ simultaneously performed on two mutually identical testpieces (1) by implementing~~:~~

step b) in such a manner that the first mean planes~~ (5)~~ of the two testpieces are mutually parallel and the mean surfaces ~~(6)~~ of the two testpieces are mutually symmetrical about a point ~~(22)~~ when the two testpieces are in the rest state, and in such a manner that the pivot axes~~ (26, 89)~~ of the two testpieces are common and mutually symmetrical about ~~said~~the point~~ (22)~~; and by implementing

~~—~~step c) in such a manner that~~by applying~~ optionally alternating opposing torques in controlled manner are applied about each pivot axis~~—(26, 89)~~ to the respective corresponding grip zones~~—(3, 4)~~ so as to impose optionally alternating opposing bending movements to the bending zones~~—(2)~~ of the two testpieces, while allowing the pivot axes~~—(26, 89)~~ to move freely relative to each other.

2. (currently amended) A method according to claim 1, the testpiece~~—(1)~~ presenting as its mean surface~~—(6)~~ in its rest state, a second mean plane~~—(6)~~ constituting a second plane of symmetry at least for the bending zone~~—(2)~~, the method being characterized in that step b) is implemented in such a manner that the second mean planes~~—(6)~~ of the two testpieces coincide when the two testpieces are in the rest state and the pivot axes ~~(26, 89)~~ are placed in the second mean planes~~—(6)~~, which thus coincide.

3. (currently amended) A method according to claim 1~~—or claim 2~~, the testpiece~~—(1)~~ presenting in its rest state a third mean plane~~—(7)~~ which is perpendicular to the first mean plane ~~(5)~~ which is crossed by the bending zone~~—(2)~~ with the grip zones ~~(3, 4)~~ being disposed on respective opposite sides thereof, and constitutes a third plane of symmetry, at least for the bending zone~~—(2)~~, the method being characterized in that step b) is implemented in such a manner that the third mean planes~~—(7)~~ of the two testpieces coincide and the pivot axes~~—(26, 89)~~ are mutually symmetrical about the third mean planes~~—(7)~~ which thus coincide.

4. (currently amended) A method according to~~—any one of~~ claim~~s~~ 1, wherein~~—to 3, characterized in that,~~ during step c), the behavior of the bending zone~~—(2)~~ of the testpieces~~—(1)~~ in pure bending is studied by measuring the resistance opposed to ~~said~~the turning by at least one of the grip zones~~—(3, 4)~~, in particular to deduce therefrom changes in the resistance to bending of the bending zone~~—(2)~~.

5. (currently amended) A method according to ~~any one of~~ claim~~s~~ 1 ~~to 4, characterized in that~~ wherein step b) is implemented by connecting each of the grip zones ~~(3, 4)~~ to the corresponding respective pivot axis ~~(26, 89)~~ by a~~n~~ plurality of arm~~s~~ ~~(30, 31, 98, 99)~~, the plurality of arms ~~(30, 31, 98, 99)~~ corresponding to the grip zones of the two testpieces being mutually symmetrical about ~~said~~the point ~~(22)~~, and by connecting the plurality of ~~two~~ arms ~~(30, 31, 98, 99)~~ corresponding to a given pivot axis ~~(26, 89) by means of~~ using~~a~~ respective controlled motor~~s~~ suitable for imparting optionally alternating opposing turning movements to the plurality of~~two~~ arms ~~(30, 31, 98, 99)~~ about the corresponding pivot axis ~~(26, 89)~~, the controlled motors ~~(105, 106)~~ corresponding to the two pivot axes ~~(26, 89)~~ being mutually identical and being allowed to move freely relative to each other.

6. (currently amended) A method according to claim 5 wherein~~as dependent on claim 4, characterized it that~~ step b) is further implemented by causing each arm ~~(30, 31, 98, 99)~~ of the plurality of arms to be elastically flexible in the first mean plane ~~(5)~~ of the corresponding testpiece ~~(1)~~ with stiffness that is greater than the stiffness of the bending zone ~~(2)~~ of the testpiece, while otherwise being rigid, and wherein~~in that~~ during step c) the resistance opposed to turning is measured by measuring the bending stresses to which at least one of the plurality of arms ~~(30, 31, 98, 99)~~ is subjected in the first mean plane ~~(5)~~ of the corresponding testpiece ~~(1)~~.

7. (currently amended) A method according to claim 5 ~~or claim 6~~, wherein~~characterized in that~~ the plurality of arms ~~(30, 31)~~ and the controlled motors ~~(105)~~ are arranged in such a manner that during step b) the pivot axes ~~(26)~~ are mutually parallel and disposed respectively on either side of ~~said~~the point ~~(22)~~.

8. (currently amended) A method according to claim 7, wherein~~as dependent on claim 3,~~ the third mean plane~~(7)~~ of the testpiece~~(1) constituting~~ comprises a mutual plane of symmetry for ~~its~~the grip zones~~(3, 4),~~ of the testpiece, and wherein~~the method being characterized in that~~ the plurality of arms~~(30, 31)~~ which correspond~~ing~~ to the grip zones of the two testpieces are mutually identical.

9. (currently amended) A method according to claim 5~~or claim 6~~, wherein the plurality of~~characterized in that the~~ arms ~~(98, 99)~~ and the controlled motors~~(106)~~ are arranged in such a manner that during step b), the pivot axes~~(89)~~ coincide and pass through ~~said~~the point~~(22)~~.

10. (currently amended) A method according to~~any one of~~ claim~~s~~ 1~~to 9~~, wherein ~~characterized in that~~ during step a) each testpiece~~(1)~~ is made or selected in such a manner as to be in the form of a plate of thickness (e) extending perpendicular~~ly~~ to the mean surface~~(6)~~.

11. (currently amended) A method according to claim 10, wherein ~~characterized in that~~ during step a) each testpiece~~(1)~~ is made or selected in such a manner that ~~said~~the thickness (e) is also constant, at least in the bending zone~~(2)~~.

12. (currently amended) A method according to claim 10, wherein~~or claim 11, characterized in that~~ during step a), each testpiece~~(1)~~ is made or selected in such a manner that it presents a dimension (L_1) perpendicular to the first mean plane ~~(5)~~ that is constant, at least in the bending zone~~(2)~~.

13. (currently amended) A method according to~~any one of~~ claim~~s~~ 10~~to 12~~, wherein~~characterized in that~~ during step a) each testpiece~~(1)~~ is made or selected in such a manner as to present a respective transition~~(107)~~ perpendicular~~ly~~ to the first mean plane~~(5)~~ between the bending zone~~(2)~~ and each of the grip zones~~(3, 4)~~.

14. (currently amended) Test apparatus for testing a testpiece ~~(1)~~ in pure bending~~, optionally in~~ or alternating bending, the testpiece ~~(1)~~ comprising two mutually opposite end grip zones ~~(3, 4)~~ and a bending zone ~~(2)~~ interconnecting the two grip zones ~~(3, 4)~~, ~~said~~the testpiece ~~(1)~~ presenting, in a rest state, a first mean plane ~~(5)~~ crossing the bending zone ~~(2)~~ and each of the grip zones ~~(3, 4)~~, and constituting a first plane of symmetry at least for the bending zone ~~(2)~~, and a mean surface ~~(6)~~ for the bending zone and for each of the grip zones, ~~(3, 4), which~~ wherein the mean surface ~~(6)~~ is perpendicular to the first mean plane ~~(5)~~, ~~said~~the apparatus ~~(18, 19, 20)~~ comprising:

a pair of clamps ~~(32, 33, 100, 103)~~ each defining a slot ~~(46, 51)~~ for securely gripping a respective grip zone ~~(3, 4)~~ of the testpiece ~~(1)~~, the slots ~~(46, 51)~~ presenting, in a relative rest position corresponding to the testpiece ~~(1)~~ being in the rest state, a first mean plane ~~(34)~~ which crosses each of the slots ~~(46, 51)~~, and a mean surface ~~(35)~~ for each of the slots ~~(46, 51)~~, ~~with~~wherein each slot ~~(46, 51)~~ presents~~ing~~ on either side of the mean surface ~~(35)~~ a respective clamping face ~~(52, 53)~~ for clamping the corresponding grip zone ~~(3, 4)~~ of the testpiece ~~(1)~~ and with the mean surface extending perpendicular~~ly~~ to the first mean plane ~~(34)~~ of the slots ~~(46, 51)~~;

~~-~~ means ~~(27, 28, 30, 31, 93, 94, 98, 99)~~ for defining a respective pivot axis ~~(26, 89)~~ for each clamp in such a manner that in the relative rest position of the clamps ~~(32, 33, 100, 103)~~, the pivot axes ~~(26, 89)~~ are perpendicular to the first mean planes ~~(34)~~ of the slots ~~(46, 51)~~, and occupy determined positions relative to the corresponding clamps ~~(32, 33, 100, 103)~~ and are free to move towards each other or apart from each other;

~~-~~ controlled means ~~(105, 106)~~ for imparting opposing, optionally alternating turning movements to the clamps ~~(32, 33, 100, 103)~~ about the corresponding pivot axes ~~(26, 89)~~ away from the relative rest position of the clamps ~~(32, 33, 100, 103)~~,

while leaving the pivot axes ~~(26, 89)~~ free to move towards each other or apart from each other; and

~~-~~ means ~~(82, 83, 84, 86)~~ for measuring the behavior of the bending zone ~~(2)~~ of the testpiece ~~(1)~~ in pure bending; wherein,

the apparatus implements the method according to claim 1 by including: ~~being characterized in that it in order to implement the method according to any one of claims 1 to 13:~~

~~it includes~~ two mutually identical sets of ~~said~~the pair of clamps ~~(32, 33, 100, 103)~~, the two sets of the clamps having the first mean planes ~~(34)~~ of their slots ~~(46, 51)~~ mutually parallel and having the mean surfaces ~~(35)~~ of the slots ~~(46, 51)~~ mutually symmetrical about a point ~~(22)~~ when the two sets are occupying ~~their~~ respective rest position~~s~~, in which the two sets are ~~each of them is~~ suitable for receiving a respective testpiece ~~(1)~~ in the rest position with the two testpieces being in a relative position such that they are mutually symmetrical about ~~said~~the point ~~(22)~~;

~~-~~ the means ~~(27, 28, 30, 31, 93, 94, 98, 99)~~ for defining the pivot axes ~~(26, 89)~~ of the pair of clamps ~~(32, 33, 100, 103) of the two sets~~ are arranged so ~~in such a manner~~ that the pivot axes ~~(26, 89)~~ are common to the two ~~both~~ sets, being mutually symmetrical about ~~said~~the point ~~(22)~~ when the two sets are ~~occupying~~in their rest positions, and being free to move relative to each other; and

~~-~~ the controlled means ~~(105, 106)~~ for imposing opposing and optionally alternating turning movements on the clamps ~~(32, 33, 100, 103)~~ of the two sets comprising ~~e~~ controlled motor means ~~(105, 106)~~ for applying opposing, optionally alternating torques about each pivot axis to the corresponding clamps ~~(32, 33, 100, 103)~~.

15. (currently amended) Apparatus according to claim 14, wherein each testpiece ~~(1)~~ presents ~~ing~~ as its mean surface ~~(6)~~ in its rest state, a second mean plane ~~(6)~~ constituting a second mean plane of symmetry at least for the bending zone ~~(2)~~, the slots ~~(46, 51)~~ of ~~said~~the pair of clamps ~~(32, 33, 100, 103)~~ possessing as mean surface ~~(35)~~ respective second mean planes

~~(35)~~ between the clamping faces~~(52, 53)~~ of each clamp~~(32, 33, 100, 103)~~ when in the rest position,

~~———~~ the apparatus being characterized in that the second mean planes of the two sets of ~~said~~the pair are mutually symmetrical about ~~said~~the point~~(22)~~ when the two sets are in the rest position.

16. (currently amended) Apparatus according to claim 15, wherein~~in which~~ each testpiece~~(1)~~ in its rest state presents a third mean plane~~(7)~~ that is perpendicular to the first mean plane~~(5)~~, that is crossed by the bending zone~~(2)~~ when the grip zones~~(3, 4)~~ are disposed respectively on either side thereof, and that constitutes a third plane of symmetry at least for the bending zone~~(2)~~, and the slots~~(46, 51)~~ of ~~said~~the pair of clamps~~(32, 33, 100, 103)~~ present, in the rest position, a third mean plane~~(108)~~ on either side of which they are disposed and which is perpendicular to their first mean plane~~(34)~~,

~~———~~ the apparatus being characterized in that the third mean planes of the two sets of ~~said~~the pair are mutually symmetrical about ~~said~~the point~~(22)~~ when the two sets are in the rest position.

17. (currently amended) Apparatus according to~~any one of~~ claim~~s~~ 14~~to 16~~, wherein~~characterized in that~~ the means~~(82, 83, 84, 86)~~ for measuring the behavior of the bending zone~~(2)~~ of the testpieces~~(1)~~ in pure bending comprise:

means~~(82, 83, 84)~~ for measuring the resistance opposed to the~~said~~ alternating turning movements by at least one of the clamps~~(32, 33, 100, 103)~~; and, where appropriate

means~~(86)~~ for deducing therefrom how the resistance of the testpiece~~(1)~~ to bending between the clamps~~(32, 33, 100, 103)~~ changes.

18. (currently amended) Apparatus according to~~any one of~~ claim~~s~~ 14~~to 17~~, wherein~~characterized in that:~~

~~———~~ the means~~(27, 28, 30, 31, 98, 99)~~ for defining the pivot axes~~(26, 89)~~ of the two sets comprises:

on each of the pivot axes ~~(26, 89)~~, two respective shafts ~~(27, 28, 93, 94)~~ on the same axis and mounted to turn relative to each other about the corresponding pivot axis ~~(26, 89)~~; and

at least four arms ~~(30, 31, 98, 99)~~ that are mutually symmetrical about ~~said~~the point ~~(22)~~, each connecting a respective one of the shafts ~~(27, 28, 93, 94)~~ to a respective one of the clamps ~~(32, 33, 100, 103)~~ corresponding to the same pivot axis ~~(26, 89)~~; and

the controlled motor means ~~(105, 106)~~ for applying opposing, optionally alternating torques about each pivot axis ~~(26, 89)~~ to the corresponding clamp ~~(32, 33, 100, 103)~~ comprise two mutually identical controlled motors ~~(105, 106)~~ arranged in such a manner as to be capable of moving freely relative to each other, each of the motors ~~(105, 106)~~ being associated with a respective one of the pivot axes ~~(26, 89)~~ and being suitable for imparting opposing, optionally alternating, turning movements to the two respective corresponding shafts ~~(27, 28, 93, 94)~~.

19. (currently amended) Apparatus according to claim 18, wherein ~~characterized in that~~ the motors ~~(105, 106)~~ are electric stepper motors.

20. (currently amended) Apparatus according to claim 18, ~~or claim 19 as dependent on claim 17, characterized in that~~ wherein each arm ~~(30, 31, 98, 99)~~ of the plurality of arms is elastically flexible in the first mean plane ~~(34)~~ of the slot ~~(46, 51)~~ of the corresponding clamp ~~(32, 33, 100, 103)~~ with stiffness greater than the stiffness of the bending zone ~~(2)~~ of the corresponding testpiece, and is otherwise rigid, and in that the measurement means ~~(82, 83, 84)~~ comprise means ~~(82, 83)~~ for measuring the bending stresses to which at least one of the plurality of arms ~~(30, 31, 98, 99)~~ is subjected in the first mean plane ~~(34)~~ of the slot ~~(46, 51)~~ of the corresponding clamp ~~(32, 33, 100, 103)~~.

21. (currently amended) Apparatus according to claim 20, wherein ~~characterized in that~~ the plurality of arms ~~(30, 31, 98,~~

~~99)~~ present in mutually symmetrical positions about the~~said~~ point~~(22)~~ at least one respective zone~~(75)~~ that is weakened in bending in the first mean plane~~(34)~~ of the slot~~(46, 51)~~ of the corresponding clamp~~(32, 33, 100, 103)~~, and wherein

~~in that~~ the means~~(82, 83)~~ for measuring bending stresses are located in the~~said~~ zone~~(75)~~ of at least one of the plurality of arms~~(30, 31, 98, 99)~~.

22. (currently amended) Apparatus according to~~any one of~~ claim~~s~~ 18~~to 21~~, wherein~~characterized in that~~ the plurality of arms~~(30, 31)~~, the shafts~~(27, 28)~~, and the motors~~(105)~~ are arranged in such a manner that in the rest position the pivot axes~~(26)~~ are mutually parallel and disposed respectively on either side of ~~said~~the point~~(22)~~.

23. (currently amended) Apparatus according to claim 22 ~~as dependent on claim 16~~, wherein the plurality of arms of the apparatus are mutually identical and each testpiece presents as its mean surface in its rest state a second mean plane and a third mean plane,

the second mean plane comprising a second mean plane of symmetry at least for the bending zone, the slots of the pair of clamps possessing as mean surface respective second mean planes between the clamping faces of each clamp when in the rest position, and wherein the second mean planes of the two sets of the pair are mutually symmetrical about the point when the two sets are in the rest position, and

the third mean plane ~~(6)~~ of each testpiece ~~(1)~~ comprising ~~constitutes~~ a plane of mutual symmetry for the grip zones ~~co~~and being perpendicular to the first mean plane, that is crossed by the bending zone when the grip zones are disposed respectively on either side thereof, and that comprises a third plane of symmetry at least for the bending zone, and the slots of the pair of clamps present, in the rest position, a third mean plane on either side of which they are disposed and which is perpendicular to their first mean plane, and wherein the third mean planes of the two sets of the pair of clamps are mutually

symmetrical about the point when the two sets are in the rest position. ~~(2, 3),~~

~~the apparatus being characterized in that the arms (30, 31) are mutually identical.~~

24. (currently amended) Apparatus according to ~~any one of~~ claim~~s~~ 18 ~~to 21~~, wherein~~characterized in that~~ some of plurality of the arms ~~(98, 99)~~, the shafts ~~(93, 94)~~, and the motors ~~(106)~~ are arranged in such a manner that, in the rest position, the pivot axes ~~(89)~~ coincide and pass through the~~said~~ point ~~(22)~~.

25. (currently amended) Apparatus according to ~~any one of~~ claim~~s~~ 14 ~~to 24~~, wherein~~characterized in that~~ the clamps ~~(32, 33, 102, 103)~~ are chamfered so as to taper towards each other when the clamps ~~(32, 33, 102, 103)~~ are in the rest position.

26. (currently amended) A testing machine for performing testing in pure bending, optionally in alternating bending, for implementing the method according to ~~any one of~~ claim~~s~~ 1 ~~to 13~~, wherein the machine ~~being characterized in that it~~ comprises:

two mutually identical motor assemblies ~~(21, 90)~~ that are mechanically mutually independent, each of the identical motor assemblies further comprising:

two clamps ~~(32, 33, 102, 103)~~ each of which is suitable for securely receiving a respective grip zone ~~(3, 4)~~ of a corresponding testpiece ~~(1)~~;

means ~~(27, 28, 30, 31, 93, 94, 98, 99)~~ for defining a relative pivot axis ~~(26, 89)~~ for the two clamps ~~(32, 33, 102, 103)~~ and occupying a determined position relative to each of the two clamps ~~(32, 33, 102, 103)~~ while in a relative rest position; and

~~—~~ controlled motor means ~~(105, 106)~~ for imparting relative and optionally alternating turning movements to the clamps ~~(32, 33, 100, 103)~~ about the relative pivot axis ~~(26, 89)~~ away from the relative rest position; and

common means ~~(86)~~ for controlling the motor means ~~(105, 106)~~ of the two motor assemblies ~~(21, 90)~~ to impart relative,

optionally alternating turning movements to the respective clamps ~~(32, 33, 100, 103)~~ about the respective relative pivot axes ~~(26, 89)~~.

27. (currently amended) A machine according to claim 26, characterized in that it comprises:

means ~~(82, 83, 84)~~ for measuring the resistance to relative turning opposed by at least one of ~~said~~the clamps ~~(32, 33, 100, 103)~~.

28. (currently amended) A machine according to claim 26 ~~or claim 27~~, wherein~~characterized in that~~ for each of the~~said~~ motor assemblies (21, 90) respectively, ~~:~~

~~—~~ the means ~~(27, 28, 30, 31, 93, 94, 98, 99)~~ for defining the relative pivot axes ~~(26, 89)~~ of the two clamps ~~(32, 33, 100, 103)~~ comprises:

two shafts ~~(27, 28, 93, 94)~~ mounted on the same axis to turn relative to each other about the relative pivot axis ~~(26, 89)~~; and

~~—~~ two arms ~~(30, 31, 98, 99)~~, each of which secures one of the clamps ~~(32, 33, 100, 103)~~ to a respective one of the shafts ~~(27, 28, 93, 94)~~; and

~~—~~ the controlled motor means ~~(105, 106)~~ for imparting relative, optionally alternating turning movement to the clamps ~~(32, 33, 100, 103)~~ about the relative pivot axes ~~(26, 89)~~, comprise a controlled motor ~~(105, 106)~~ that is mechanically independent of the control motor ~~(105, 106)~~ of the other motor assembly ~~(21, 90)~~ and that is suitable for imparting relative, optionally alternating, turning movements to the two shafts ~~(27, 28, 93, 94)~~.

29. (currently amended) A machine according to claim 28, wherein~~characterized in that~~ each controlled motor ~~(105, 106)~~ is an electric stepper motor.

30. (currently amended) A machine according to claim 28, wherein ~~or claim 29, as dependent on claim 27, characterized in~~

~~that~~ each of the plurality of arms ~~(30, 31, 98, 99)~~ is elastically flexible in a mean plane ~~(34)~~ perpendicular to the pivot axis ~~(28, 89)~~ and is otherwise rigid, and ~~in that~~ the measurement means ~~(82, 83, 84)~~ comprise means ~~(82, 83)~~ for measuring the bending stresses to which at least one of the plurality of arms ~~(30, 31, 98, 99)~~ is subjected in ~~said~~the mean plane ~~(34)~~.

31. (currently amended) A machine according to claim 30, whereine~~haracterized in that~~ each of the plurality of arms ~~(30, 31, 98, 99)~~ presents at least one zone ~~(75)~~ that is weak in bending in the~~said~~ mean plane ~~(34)~~, and whereine~~in that~~ the means ~~(82, 83)~~ for measuring bending stresses are located in the~~said~~ zone ~~(75)~~ of at least one of the arms ~~(30, 31, 98, 99)~~.

32. (currently amended) A machine according to ~~any one of~~ claim~~s~~ 26 ~~to 31~~, whereine~~haracterized in that~~ the plurality of arms ~~(30, 31)~~ are mutually identical.

33. (currently amended) A machine according to ~~any one of~~ claim~~s~~ 26 ~~to 32~~, whereine~~haracterized in that~~ the clamps ~~(32, 33, 100, 103)~~ are chamfered.